Stress Discrimination by Native Speakers of European Portuguese – An ERP Study

Shuang Lu[1], Susana Correia[2], Rita Jerónimo[3], Marina Vigário[2] & Sónia Frota[2]

[1]School of Foreign Languages – Renmin University of China, [2]Universidade de Lisboa - Laboratório de Fonética & Lisbon Baby Lab – CLUL/FLUL, [3]ISCTE-IUL – CIS

1st Meeting of PhD Students of the Mind and Brain College, University of Lisbon, December 2nd, 2015

Introduction

- Lexical stress - prominent syllable in a word – e.g. *CAsa* 'house', *saPAto* 'shoe'

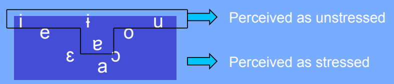
Stress	Languages	Discrimination
Fixed	e.g. Finish, Polish, Turkish	☒
Variable	e.g. English, German, Spanish	☑

Table 1 Stress across languages and discrimination (Dupoux et al. 1997, Dupoux, Peperkamp & Sebastián-Gallés 2001, Dupoux et al. 2008, Peperkamp, Vendelin & Dupoux 2010, Domahs et al. 2012)

- Previous research has suggested that perceptual discrimination may occur at the unintentional level, but not at the intentional/behavioral level (Tremblay, Kraus & McGee 1998)

European Portuguese (EP) word stress

- Variable stress, with penultimate stress being more frequent than final stress (Frota et al. 2010); lexical stress signals prosodic words, which are relevant to segment the speech stream; stress is a cue for word right periphery
- Vowel reduction has been claimed to be the primary cue for the perception of stress in EP



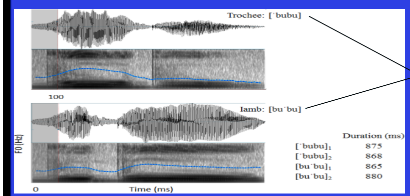
- Duration, which is the main prosodic cue of word stress in the absence of vowel reduction (Delgado-Martins 1977, Andrade & Viana 1989), was not sufficient for the processing of stress contrasts; Pitch is a low correlate of stress, due to the sparse distribution of pitch accents in EP (Vigário & Frota 2003)
- Behavioral studies have shown that without vowel quality cues, speakers of EP exhibit a stress "deafness" effect similar to that found for languages with fixed stress (Correia et al. 2015)

Hypothesis:

If native speakers of EP are able to discriminate stress in the absence of vowel reduction at the unintentional level, they would show MMN and late negativity to both the trochaic and iambic conditions.

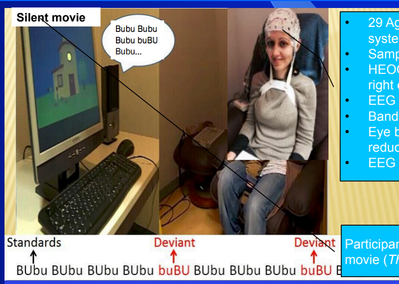
Method

Passive oddball paradigm - two ERP components: (1) MMN; (2) Late negativity - **TEST FOR AUDITORY DEVIANCE DETECTION**



Stimuli: segmentally similar nonwords contrasting in stress position only

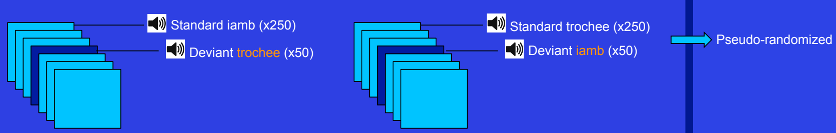
Figure 1: *Spectrograms of the trochaic and iambic stress patterns. Physical differences start at 100 milliseconds.*



- 29 Ag/AgCI scalp electrodes according to the international 10-20 system of electrode placement
- Sample rate: 500Hz
- HEOG outer canthus of each eye; VEOG above and below the right eye
- EEG data referenced online in the left mastoid
- Band-pass filtered from 0.1 to 30 Hz (24dB/oct; zero phase-shift)
- Eye blink artifacts were corrected offline using the ocular artifact reduction algorithm implemented in the Edit 4.3 software
- EEG data were segmented offline into epochs of 1000ms

Participants were given comprehension questions regarding the movie (*The Gold Rush*) after each block

Procedure: 2 blocks



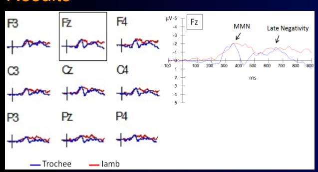
600 trials in total (Average number of trials analyzed for each stimulus type: 96)
(Stimulus presentation was controlled by the E-Prime 2.0 software)

Participants: 24 native speakers of EP (6 Males) aged 18-32 (M = 21.92, SD = 3.97); right-handed (Edinburgh Handedness inventory) with normal vision and hearing; no history of speech or neurological impairment.

Data analysis and experimental design:

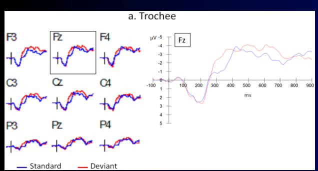
- Mean amplitudes - 2 × 2 × 2 × 2 repeated measures ANOVAs: Discrimination (deviant vs. standard), Hemisphere (left vs. right) and Anteriority (anterior vs. posterior) as within-subject factors, and Group (high accurate vs. low accurate) as between-subject factors.

Results



A MMN component was elicited for the deviant versus standard stimuli, with a prominent frontal distribution between 300 to 400 ms for the trochaic stimulus, and between 300 to 500 ms for the iambic stimulus. A late negativity component was also observed at the frontal and central electrodes between 500 to 700 ms for the trochaic stimulus and between 500 to 900 ms for the iambic stimulus.

Figure 1: *Grand-average difference waves (deviant minus standard) of the frontal electrodes (F3, Fz and F4), the central electrodes (C3, Cz and C4) and the parietal electrodes (P3, Pz and P4) for the trochaic and iambic stress patterns.*



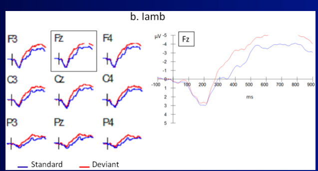


Figure 2: *Grand averages of the frontal electrodes (F3, Fz and F4), the central electrodes (C3, Cz and C4) and the parietal electrodes (P3, Pz and P4) for the whole group. a) Trochaic stress pattern (deviant). b) Iambic stress pattern (deviant).*

a. Trochee	300-400	400-500	500-600	600-700	700-800	800-900
Disc	***			*		
Ante	***	***	**	**	***	***
Hemi		*	**	*	**	**
Disc x Hemi		*				
Disc x Ante				*		
Hemi x Group		**	*			
Disc x Hemi x Ante	*	**	**	**	*	
Disc x Hemi x Ante x Group			**	*		

a. Iamb	300-400	400-500	500-600	600-700	700-800	800-900
Disc	***	***	***	***	**	*
Ante	***	***	***	***	***	***
Hemi		*				
Group						*
Disc x Ante					***	**
Hemi x Ante			*	*		*
Hemi x Ante x Group			*	**	**	**

Difference waves for the six time windows: 2 × 2 × 2 × 2 repeated measures ANOVAs [Stress (Trochee vs. Iamb), Hemisphere (left vs. right), and Anteriority (anterior vs. posterior) as within-subject factors, and Group (high accurate vs. low accurate) as between-subject factors]:

- Significant main effect of Stress in the time windows of 400-500ms, and marginal effect in the time windows of 500-600ms, with the negativity being more prominent in the iambic condition than in the trochaic condition. ➔ **Trochees ≠ Iambs**

Table 2. *Main effects and interactions in the six time windows for a) trochaic stress pattern; and b) iambic stress pattern. *** p ≤ .001, **p ≤ .01, *p < .05*

Discussion

- We recorded native EP speakers' ERPs to examine whether they can unintentionally discriminate CVCV nonsense words with trochaic and iambic stress patterns in the absence of vowel quality cues.
- Both the trochaic and iambic conditions yielded MMN and late negativity, indicating that native speakers of EP are able to discriminate the two stress patterns without vowel reduction at the unintentional level. Inconsistent with previous behavioral studies, which demonstrated a stress "deafness" effect in the EP speakers when the vowel reduction cue was removed.
- Evidence that the participants are able to group non-words with different stress types together on the basis of higher level category representations.
- The MMN and late negativity components in the iambic condition span over a larger temporal window than in the trochaic condition, indicating that native speakers of EP may be more sensitive to the iambic than the trochaic stress pattern (AT ODDS with the frequency distribution of the stress patterns in EP and previous literature on other languages – e.g. Russian - Molczanow, Domahs, Knaus & Wiese 2013).
- Preliminary behavioral results (ABX task with the same participants) replicated the stress "deafness" effect previously found and showed that participants had more accurate and faster discrimination when X is an iambic stimulus. A recent study on native EP infants' perception of stress (see Poster 32) also showed that 5-6 month old EP-learning infants prefer the iambic to the trochaic stress pattern (Butler et al. 2015, Frota 2015). Results in adult and infant studies suggest that EP speakers are more sensitive to iambic stress.

Conclusion

- Results argue against stress "deafness" in EP at the unintentional level and suggest the need of a multi-methodological approach to stress processing.

FCT Fundação para a Ciência e a Tecnologia

Projecto EBELa: EXCL/MHC-LIN/0688/2012 (see Poster 29)

correia.smd@gmail.com

http://www.fl.ul.pt/LaboratorioFonetica/